ROYAL ASTRONOMICAL SOCIETY.

VOL. X. *February* 8, 1850. No. 4.

THE Annual General Meeting of the Society, G. B. AIRY, Esq., Astronomer Royal, President, in the Chair.

The following gentlemen were proposed as Associates of the Society:—

Professor Benjamin Pierce, Dr. Bache, Professor O. M. Mitchell, and Sears C. Walker, Esq.,—all of the United States.

Richard Farley, Esq. First Assistant on the Nautical Almanac Establishment, and Henry Perigal, Jun. Esq. of Smith Street, Chelsea, were balloted for and duly elected Fellows of the Society.

Report of the Council to the Thirtieth Annual General Meeting.

The Council have once more the pleasure of meeting their constituents with the information that the prosperity of the Society continues unabated, and that the progress of the science for the cultivation of which it was established continues unchecked.

The Report of the auditors, subjoined, will show the state of the finances:—

RECEIPTS.

	£	s.	d.
Balance of last year's account	382	5	3
1 year's dividend on £ 900 Consols	26	4	4
½ ditto on £2317 6*s.* 11*d.* New 3½ per Cents	36	11	2
½ ditto on £2363 12*s.* 6*d.* ditto	37	5	10
On account of arrears of contributions	68	5	0
82 contributions (1849–50)	172	4	0
6 ditto (1850–51)	12	12	0
7 compositions	147	0	0
33 admission fees	69	6	0
27 first year's contributions	49	7	0
Sale of Memoirs, &c.	71	16	6
	£1072	17	1

EXPENDITURE.

Cash paid for investment of 4 compositions	84	0	0
Mr. Barclay, for printing Memoirs	111	2	2
Ditto for printing Monthly Notices, &c.	127	9	0
Carried forward	£322	11	2

EXPENDITURE (*continued*).

	£	s.	d.
Brought forward	£322	11	2
Mr. Basire, engraver	13	14	6
Mr. Wyon, medals	34	13	0
Taxes { Land tax and window duty, 4 quarters ... 8 5 2			
Taxes { Income and property tax, 4 quarters 1 9 2	9	14	4
J. Williams, for 1 year's salary as Assistant-secretary	100	0	0
Ditto commission on collecting £443 10*s.* 6*d.*	22	3	6
Charges on books, and carriage of parcels	3	0	5
Postage of letters and Monthly Notices	26	6	3
Porter's and charwoman's work	13	3	4
Tea, sugar, biscuits, &c. for evening meetings	13	13	0
Coals, candles, &c.	12	18	6
Sundry disbursements by the Treasurer	20	4	8
Balance in the hands of the Treasurer (Jan. 1850)	480	14	5
	£1072	17	1

The assets and present property of the Society are as follows:

	£	s.	d.
Balance in the hands of the Treasurer	480	14	5
1 contribution of 7 years' standing £14 14 0			
4 ——— of 6 ditto 50 8 0			
1 ——— of 5 ditto 10 10 0			
4 ——— of 4 ditto 33 12 0			
3 ——— of 3 ditto 18 18 0			
7 ——— of 2 ditto 29 8 0			
18 ——— of 1 ditto 37 16 0			
	195	6	0
Due for books, &c.	14	17	0

£900 3 per Cent Consols.
£2363 12*s.* 6*d.* New 3½ per Cent Annuities.
Unsold Memoirs of the Society.
Various astronomical instruments, books, prints, &c.

The stock of volumes of the *Memoirs* still in the Society's possession is as follows:—

Vol.	Total.	Vol.	Total.	Vol.	Total.
I. Part 1	46	IV. Part 2	172	XI.	249
I. Part 2	91	V.	186	XII.	260
II. Part 1	108	VI.	204	XIII.	281
II. Part 2	74	VII.	229	XIV.	466
III. Part 1	135	VIII.	216	XV.	255
III. Part 2	155	IX.	224	XVI.	289
IV. Part 1	158	X.	238	XVII.	298

The progress and present state of the Society, with respect to Fellows and Associates, is as follows :—

	Compounders.	Annual Contributors.	Non-residents.	Patroness, and Honorary.	Total Fellows.	Associates.	Grand Total.
February 1849	124	130	71	6	331	57	388
Since elected	3	29	...	...	32	...	32
Deceased	−5	−2	−1	...	−8	...	−8
Resigned	...	...	...	...	...	...	...
February 1850	122	157	70	6	355	57	412

The instruments belonging to the Society are now distributed as follows :—

The *Harrison* clock,
The *Owen* portable circle,
The *Owen* portable quadruple sextant,
The *Beaufoy* circle,
The *Beaufoy* transit,
The *Lee* circle,
The *Herschelian* 7-foot reflector,
The *Greig* universal instrument,
The *Smeaton* equatoreal,
The *Cavendish* apparatus,
The Universal quadrant by Abraham Sharp,
The 7-foot Gregorian reflecting telescope (late Mr. Shearman's),
are in the apartments of the Society.

The Brass quadrant, said to have been *Lacaille's*,
is in the apartments of the Royal Society.

The Standard scale
is in the charge of the Astronomer Royal, with the consent of the Council, to be employed in the formation of a new Standard Measure, under the direction of the Standard Committee.

The remaining instruments are lent, during the pleasure of the Council, to the several parties undermentioned, viz. :

The *Fuller* theodolite, to the Lords of the Admiralty.
The *Beaufoy* clock,
The two invariable pendulums, } to the Royal Society.
The *Wollaston* telescope, to Professor Schumacher.
The Variation transit (late Mr. Shearman's), to Mr. J. Rees.
The other *Beaufoy* clock, to Mr. J. Drew.

The Council observe with satisfaction the steady growth of the Society in numbers, a proof of increasing interest in the science of astronomy. And this satisfaction is augmented by the reflection that a very large proportion of the newly-elected Fellows are persons who are actually engaged in the cultivation of some branch of the science.

The Council call the attention of the Society to the manner in which they have felt it their duty to propose to increase the list of Associates, by the addition of names from the United States. The very great impulse given to astronomy in that part of the world within the last few years will ultimately demand many acknowledgments of the same kind.

Since the last meeting, the publication of the seventeenth volume of the *Memoirs* has been made, containing the papers read in the Session 1847–48. The volume of *Monthly Notices* corresponding has also been published, as well as that which follows, the latter being vol. ix. of the series. The eighteenth volume of the *Memoirs* is printed within a sheet. The plan which connects the volumes of *Memoirs* and those of *Monthly Notices* (that they are supplementary to each other) is now, the Council hope, well understood by all the Fellows; but it may be useful to allude to it.

It will be observed that the Annual Reports, which are given at length in the *Monthly Notices*, are reprinted in the *Memoirs*. This has always been done; but it will strike every one that there is an apparent superfluity and needless expense in continuing the practice, now that the two volumes are made to form one publication, and each is considered as necessary to the other. The Council are desirous the meeting should know that this point has not escaped their attention, and that the continuance of the old practice has been a result of deliberation. Among the reasons which have guided them is one which has been strongly urged, and which is of force, so long as the funds will admit of the outlay without detriment to the wants of the astronomy of the day. It is well known that publications of different sizes, as quarto and octavo, are with difficulty kept together for centuries: and that, as years go by, there is much reason to suppose the *Memoirs* and the *Monthly Notices* will be found separate from each other. It is also well known that the demand for any set of transactions, when ancient, is very much augmented by their containing historical information; and abundance of instances might be given in which books are now sought for on that account, in preference to others of more intrinsic value. Until these reasons have received the fullest scrutiny, the Council have thought it best to continue the printing of the Annual Reports in the *Memoirs*, satisfied that, by so doing, they are increasing the permanent value of that series to an extent which will fully justify them, until such time as the money thus expended is imperatively required for some purpose of still greater utility.

The *Monthly Notices* in their extended form have now been a considerable time before the Society, and appear to have been

favourably received. There is, however, one considerable drawback; the expense of printing and forwarding the *Notices* is very large, larger perhaps than is quite consistent with extreme prudence. Still the advantages are so considerable that the Council does not recommend any change at present. All superfluity of language will be retrenched, without altering or obscuring the views of the contributor, and every essential preserved. The members will have remarked with pleasure the admirable lectures delivered by the President, which he has himself kindly prepared for the press. Although this additional labour has at times been exceedingly inconvenient to him, he has felt the justice of the remark that a report by any other person would be imperfect and faulty, and he has submitted to a very irksome task for the general good and the especial credit of the Society.

The Council cannot pass over without an expression of satisfaction the frequent arrival of presents of a highly interesting and useful class; they refer to models of instruments and contrivances, which are very often not only the proof of successful thought, but the instigation of it in others. At a time when all that was once held most sacred and venerable in the forms of instruments is undergoing unusual scrutiny, and new propositions of a singular character are emanating from authorities high in the estimation of all, it is clear that the field is peculiarly open to every inquirer, and also that the number of such inquirers is much augmented. To the Astronomer Royal, therefore, for various presents of models constructed by himself, in illustration of his addresses at our meetings, and particularly for one of the prime vertical transit lately erected at Pulkowa; to Mr. Nasmyth, for a model of azimuth and altitude mounting of a reflecting telescope; and to Mr. Cowper, for an equatoreal mounting of the same instrument, the thanks of the Council are most justly due. It is not the least important feature of these useful presents, that they are lessons in the construction of such illustrations at a cost much below that which was once thought requisite: time was when it was supposed that nothing of the kind was worthy of being offered to a society, unless it were highly finished in metal. The Council need hardly say, that the results of valuable contrivance in plain wood are as acceptable as those of thought or research in homely handwriting; neither polished metal nor calligraphy are necessary to make such offerings useful to astronomers.

The Council have commenced the printing of a new Library Catalogue, several sheets of which have been struck off. It has been compiled by the Assistant Secretary; and the Council have to acknowledge with gratitude the offer of Mr. Woolgar to make the final examination and superintend the printing. Such a catalogue has been much wanted for some years past, not only on account of the large accessions which the library has received from the friends of the Society, but still more that the Fellows may have the means of knowing the books which were added at the time when the Mathematical Society was incorporated with ours. Of

our own books we may say that they are mostly such as we should be thought likely to have; so that those who want them would naturally inquire for them here. But in the incorporated library there is a large stock of the books which might aid an inquirer in other subjects besides astronomy, but of which he would hardly suppose we were possessed unless a printed catalogue, such as he could consult at home, should suggest to him where to find them. The catalogue will give the titles with sufficient fulness to identify the works, and will aim at such an amount of cross reference, and, in some important cases, of description of contents, as, without unduly increasing the expense, will add much to its utility.

At the close of the Report for last year, the Council alluded to the unsatisfactory position of our respected and venerable Associate, Professor Schumacher, and mentioned their application to Lord Palmerston for his interposition and good services. His lordship, with a readiness which entitles him to our warmest thanks, immediately represented the case to the Danish government, and received the most positive assurances that the Professor would be preserved from all injury, and left in peace to continue his valuable labours. Unfortunately the disputes between Denmark and the Duchies are still unsettled; and so long as this unhappy state continues, we fear the Professor's condition, respected though he is by all parties, must be unsettled too. We gladly state that the scientific representatives of almost every civilised state have cordially bestirred themselves in Professor Schumacher's favour — a gratifying proof of the honour in which he is universally held, and a testimony to the admitted importance of his long and useful labours. We are, moreover, rejoiced to find that his own peculiar troubles have had no benumbing effect on his intellectual exertions. The *Astronomische Nachrichten* is continued with the same talent and regularity as heretofore (even a supplementary part has been published in the last year), and the observatory of Altona is in full activity. Let us hope that, in the general return to order, the complicated affairs of Schleswig-Holstein may receive an early and satisfactory solution.

The Council have awarded the gold medal to M. Otto Struve, the son of our illustrious Associate, and himself an Associate, for his researches on precession, and on the effect of the motion of the solar system upon it. The President will, as usual, state the grounds of this decision. Astronomy is, more than any other, a science in which the hereditary tendency is frequent, and in the present instance it is very strongly developed. The Council cannot omit to acknowledge their obligation to Mr. Main, who drew up for their guidance a most elaborate and lucid report on the state of the question, and on M. Otto Struve's researches upon it.

The Council have to regret the loss, by death, of Major Shad-

well Clerke, Major Lysaght, Major Wilcox,* Rear-Admiral Sir S. J. B. Pechell, Lewis Hayes Petit, and Bartholomew Bidder, Esqrs.

Major Thomas Henry Shadwell Clerke was born at Bandon, in Ireland, and educated at the Royal Military College of Marlow, where his diligence and conduct gained him the distinction among his young associates of being a cadet officer. Having entered the army, he was appointed to an ensigncy in the 28th Regiment of foot, on the 30th of July, 1805, and was made a lieutenant in the 5th Regiment in 1807. He served with acknowledged credit and gallantry during the first years of the Peninsular campaigns, having been present at the general actions of Roleia, Vimiera, Corunna, and Busaco; and at the combats of Almeida, the Coa, Pombal, and Redinha, at the last-mentioned of which affairs, on the 12th of March, 1811, he lost his right leg. Having become, on the conclusion of the war, a captain of the Staff Depôt, he was promoted to a majority in 1830, and was placed upon half-pay in June 1833.

Major Clerke was highly esteemed as an accomplished and very useful officer, and well known as the originator and able editor of that successful periodical the *United Service Journal*. This work he conducted from its commencement, in January 1829, till the month of June 1842, during which time he zealously seconded every undertaking for the advancement of professional knowledge among naval and military officers. In carrying out this object, he also lent his aid towards the establishment of the United Service Institution. He was, moreover, a Fellow of the Royal, the Geological, and the Royal Astronomical Societies, and at his demise had become Foreign Secretary to the Royal Geographical Society—an office for which his acquaintance with several of the modern languages well adapted him.

Major Clerke expired on the 19th of last April, under an attack of paralysis, at his residence in Brompton Grove, deeply regretted by a numerous circle of friends and acquaintance for his excellent social qualities and integrity of character.

Major Thomas Lysaght was an officer of very considerable merit and acquirements, of the Honourable East India Company's forces. He entered the Bengal army on the 3d of June, 1820, as ensign in the left wing of the 1st European Fusileers, was made a lieutenant in 1823, a captain in 1837, and a brevet-major in 1846. During this time, his knowledge of military details and his practical facility in the Oriental languages strongly recommended him for special employment, and he was permitted to enter the Nizam's service in 1841. Here, in a sphere of great usefulness, he was attacked by an insidious disease, and died at Hingolee on the 29th of last June.

* The Council are obliged to defer till next year some account of the life of Major Wilcox.

Rear-Admiral Sir Samuel John Brooke Pechell, Bart., was an officer of distinguished merit, and his attention to naval gunnery is evinced by his publications, especially that entitled *Observations upon the Fitting of Guns on board his Majesty's Ships*, of which three editions were circulated.

Sir Samuel was born in 1785, and was sent to sea at the early age of eleven years, under the protection of his maternal uncle the late Admiral Sir John Borlase Warren. During his novitiate, and while he served as lieutenant, he saw much active service, and assisted at the capture of an 80-gun ship (*Marengo*), three French frigates (*La Néreide*, *La Belle Poule*, and *l'Africaine*), one large corvette, and several stout privateers. He was made a commander in 1807, and posted into the *Cleopatra* of 36 guns. In this ship he displayed great gallantry on the 23d of January, 1809, in an action with a French frigate of the largest class (*La Topaze*), which had anchored under the protection of a battery at Guadaloupe, and was completely silenced before the *Cleopatra's* consorts arrived. The commander-in-chief was so pleased with the exploit, that he offered Captain Pechell the command of the prize, as a token of his approbation, saying to him at the same time, "As you have won her, you shall wear her." He further distinguished himself at the capture of Martinique, and on the shores of the United States, and served till the general peace in 1814. He afterwards commanded the *Sybille*, of 38 guns, on the Mediterranean station, where he was actively employed in the suppression of piracy among the Greek islands.

Sir Samuel Pechell was nominated a Companion of the Bath in 1815, and a Knight Commander of Hanover in 1833. He sat in Parliament for Helstone in 1830, and for Windsor in 1833, and was twice a Lord of the Admiralty. He died, after a lingering illness, on the 3d of last November, at his residence in Hill Street, Berkeley Square, in the 65th year of his age.

Of Mr. L. H. Petit and Mr. B. Bidder the Council have received no information. The former was known as an amateur lover of astronomy, and at one time a constructor of telescopes, and as a man of much information. The latter was Actuary of the Royal Exchange Life Assurance Company, and was attached to science in general, and a cultivator of mathematics.

John Goldingham, Esq. is known to science by his long occupation of the post of Astronomer at Madras. He died at Worcester, at an advanced age, a few days before the last annual meeting of this Society. But it is not so generally known that he held a public post as a civil engineer in India during the early part of his tenure of the observatory. The banqueting-room at Madras, a building universally admired, was erected by him in 1800. As astronomer, he published two volumes of observations: one of them, published in 1827, contains his observations of the length of the pendulum, of the velocity of sound, of meteorological pheno-

mena, as well as determinations of the longitude of Madras, and a discussion of the longitudes of the three Presidencies. Some of these papers had been previously printed in the *Philosophical Transactions*. It does not appear that Mr. Goldingham was much in communication with European astronomers during the active part of his Indian life; and to the want of concert among astronomers of that time, and also to the absence of such a point of union then as is now afforded by our Society, it is perhaps to be attributed that no continuous astronomical effort, no regular series of observations, appears to have been made by him.

The construction of the large transit circle for the Royal Observatory of Greenwich has been steadily, though slowly, advancing. The only part of the work hitherto effected to which it appears necessary to invite the notice of the Society, is the method of turning the pivots. It has already been stated to the Society that the instrument is made of cast-iron, its pivots being cast in the same flow of metal with the conical transit-axis; and that the surface of these pivots is made nearly as hard as hardened steel by the process technically called *chilling*, that is, casting in a mould of warmed iron. It would have been impracticable to turn these by the point of any tool except a diamond. Mr. May, however, has arranged a method of turning which may roughly be described as follows. The axis (where the iron is soft) having been very carefully bored, and a long bar having been very nicely fitted to it, this bar is made to carry an apparatus, of which the efficient part is a copper wheel, whose edge is presented to the external surface of the pivot; this copper wheel is charged with emery powder, and is made to revolve very rapidly, and thus the surface of the pivot is cut away. At the same time, the bar which carries that apparatus is made by other machinery to slide slowly up and down the axis, and to rotate slowly; thus presenting the acting edge of the copper wheel in succession to every part of the pivot surface, and giving it a form not only circular but cylindrical also. The figure of the pivots thus turned has been tested, and appears to be perfect. The Council have reason to hope that Mr. May will, at the completion of this work, present the Society with an accurate description of a method which they cannot but regard as highly important in the present tendency of astronomical instruments to become larger and larger, while the requirements of accuracy in the mechanical movements are in nowise diminished.

Although a locality has been provided for the intended reflex zenith telescope at the Royal Observatory, no active step has yet been taken in its construction. The Astronomer Royal proposes to wait for an opportunity of trying the 10-foot object-glass of the existing transit-instrument (which can be obtained only after mounting the transit-circle) before determining finally whether that object-glass, or one of larger aperture, should be used for the reflex zenith telescope.

At Cambridge the observations have been chiefly directed to the determination of positions of the recently discovered planets, and of the places of stars used for reference in equatoreal observations. From press of business, Professor Challis has been compelled to desist from carrying on the equatoreal observations of the new planets on the same scale as in the two preceding years, and this is the less necessary, as the excellent observations of Liverpool, Markree, and Hamburg, form a full and pretty continuous history of these bodies. It is understood, that when Mr. Hartnup finds an object become so faint as not to admit of accurate observation, he will give notice to the Professor, who will then bring his more powerful telescope into action. Meanwhile Professor Challis has thought it advisable to substitute for them, in part, a class of observations of a simpler character, the utility of which cannot be questioned. As the new planets generally occupy positions within a few degrees of either side of the ecliptic, the exact places of the stars in this region of the heavens become important as points of reference in the equatoreal observations of these bodies. Professor Challis has accordingly commenced a series of meridian observations of stars, to the ninth magnitude inclusive, situated in a zone extending from 5° above to 5° below the ecliptic. The observations were at first made by the mural circle used as a transit circle, but latterly both transit and mural circle have been employed to obtain places as exact as possible.

The volume of Observations of 1843 was published in the latter half of 1848; that for 1844 was published during the last year; and the printing of that for 1845 is now commenced. Some changes in the arrangement of the University lectures will leave additional time at Professor Challis's disposal for the reduction of the arrears of printing. As one means towards this end, he has thought it expedient to make an alteration in the printing of the transit observations, by which the transit as observed, and the leading steps of the calculation, are contained in one page, instead of extending over opposite pages as formerly. The alteration has been made on the principle of retaining all that is recorded in taking the observation, and omitting only some results in the course of the reduction, leaving the same opportunity of verifying the accuracy of the final result as before. A similar plan has been fixed upon for abbreviating the printing of the circle observations. The effect of these alterations will be to allow of putting the meridian observations of two or even three years into one volume, and thus obviate the necessity of repeating the introduction for each year. The time and expense of passing them through the press will consequently be diminished, and the value of the published observations will be in no material respect reduced.

The instruments continue in a satisfactory state.

The principal occurrence to report from the Radcliffe Observatory at Oxford is the erection of the heliometer.

The arrival of the instrument was mentioned in last year's Report, and the building for its reception was begun in the month of March last: by the beginning of October it was sufficiently advanced to allow of the instrument being placed on its pier, which was done under the immediate personal superintendence and direction of Mr. A. Repsold.

The instrument was packed in eleven large cases, which had to pass through a variety of conveyances in the long journey from Hamburg to Oxford. Notwithstanding this, such had been the care in packing it, that not the slightest injury was detected in any part.

This is not the place to enter into a detailed description of the instrument or of the observatory. Such a description, accompanied by illustrative drawings, will probably appear in due time. Here it will be sufficient to mention that the diameter of the divided object-glass is $7\frac{1}{2}$ inches in diameter, with a focal length of 10 feet 4 inches, carried by an equatoreal mounting designed by MM. Repsold themselves. This mounting was applied for the first time to an instrument sent to Christiana, in Norway, some years ago. In its general principle it is the same as Fraunhofer's, but differs in having the hour-circle at the upper end of the polar axis instead of the lower end. This arrangement admits of an hour-circle of large dimensions. In the Radcliffe heliometer the hour-circle is $2\frac{1}{2}$ feet in diameter. The declination-circle is of the same size.

As a Heliometer the instrument presents some peculiarities of construction. Among these, the movement of the segments into which the object-glass is divided deserves the first mention.

In the instruments hitherto constructed the segments have been made to move in a straight line; consequently, when they are separated, they present images unequally distant from the observer's eye, and when the separation is great there is indistinctness of one image. This inconvenience was partially obviated by giving a circular motion to the eye-piece.

Bessel felt this defect long ago, and suggested to Fraunhofer the practicability of removing it; though it appears that the means of doing so did not occur to that distinguished artist. When the Radcliffe heliometer was ordered, Bessel again called the attention of MM. Repsold to the subject, and with better success. These skilful artists, by a device not less simple than ingenious, have made the segments move in the arc of a circle, the radius of which is their focal length.

In an historical point of view, we may be excused mentioning that they had been anticipated in this contrivance as long ago as 1767 by M. De Charnières, an officer of the French navy, distinguished as being among the first of those who applied themselves to the practical solution of the problem of finding the longitude at sea by lunar distances. For measuring distances, not exceeding $5^{\circ}\frac{1}{2}$, De Charnières constructed an instrument which he called a "Mégamètre;" this is, to all intent and purpose, the type (on a small scale, of course) of the modern heliometer. De Charnières'

instrument was not quite unnoticed at the time, as we may gather from the fact of its having been used in marine surveying, and favourably mentioned by Captain Phipps (the first Lord Mulgrave) in his voyage towards the North Pole in 1773. It is described by its inventor in a work, *Théorie et Practique des Longitudes en Mer*, Paris, 1772. In it we find the circular motion given on the same principle as by the Repsolds, though De Charnières' construction was not known to these distinguished artists.

The next peculiarity is the place of the Position Circle, which, instead of being close to the object-glass, is two-thirds down the length of the tube. By this arrangement it is accessible to the observer in all positions of the telescope.

The last, and a capital peculiarity, is the Scale for measuring the distances, and the mode of reading it off. In the Königsberg heliometer, it will be remembered that the measures were read off from micrometers *at the object-end* of the telescope, so that after every observation that end must be lowered, or the observer must climb up to it. This involved much loss of time and some risk of deranging the relative positions of the segments; to avoid this, MM. Repsold have applied an *interior* scale, illuminated by a galvanic stream acting on a platinum wire, and read off by long micrometer microscopes, the eye-pieces of which are adjacent to the observer's eye, so that he may make and read off his measures without leaving his chair. This, we believe, is the first application of galvanic light to an astronomical instrument, and is perfectly successful.

The object-glass is by Merz of Munich. The division of the glass impairs its power as a *seeing* telescope, for in no position of the segments is it practicable to obtain strictly a single image. But as a *measuring* telescope,—the light in which it should be considered,—it is all that can be desired. When the segments are separated, both images are clear and round, and those rays of false light at right-angles to the line of section, which Bessel observed in the Königsberg instrument, are seldom to be seen here. The present experience of the instrument is very favourable, but on this point it will be needless to enlarge, as the Society will, in all probability, soon have the means of judging of it by some of the results obtained.

At a time when it is not unusual to hear complaints of the apathy shown to the concerns of science, it is but justice to state that this instrument is an *unsolicited* offering of the Radcliffe Trustees to the astronomical appliances of our country.

The routine operations of the Radcliffe Observatory during the past year have been confined chiefly to the completion of the *Circumpolar Catalogue*. Very few stars in Groombridge's *Catalogue* are now left unobserved, and in the course of the present year this work may probably be brought to a close. But when this is done, and the current reductions completed, as they are annually, the labour of arranging the work of eleven years into a catalogue reduced to one epoch will be considerable—more than, with his present force, the

Radcliffe Observer can hope to get over in a short time, even if his attention were not distracted, as it is likely to be, by the heliometer. As the catalogue is of the greatest interest to astronomers, and as it is always desirable that such works should be published as soon as possible after completion, we feel assured that the Radcliffe Trustees will afford the necessary assistance for attaining this end, when its great utility, as one of the permanent landmarks in Astronomy, is pointed out.

It would be premature to speak of the future course of this establishment. Those subjects of observation to which the heliometer is more strictly applicable will naturally occupy a large share of its attention, and among them the important question of the parallax of the fixed stars will take a foremost place. Such inquiries will occupy more time than is expressed in the visible results, and are alone sufficient to employ the present personal force of the establishment. Nevertheless, we cannot refrain from expressing our hope that meridian observations on more than a small scale will continue to be carried on. We say, "on more than a small scale," because *some* meridian observations must continue to be made; those, for instance, for determining the absolute places of zero stars used in observations with the heliometer, those for the determination of time, &c.

The planets and brighter stars, even to the sixth magnitude, have been, or are in course of being, pretty well examined; but of the smaller stars, such as those in Lalande's or Weisse's *Catalogues*, the stars in the remaining zones of Bessel, Argelander, and Lamont, we know little beyond their places given in those collections. In the present state of astronomy, it would seem that a revision of such stars would be a work of considerable interest and importance. Of course, an undertaking of such labour can only be accomplished slowly and gradually, and as such is well suited to the powers of the Radcliffe Observatory. The question for consideration is not the building of a *new* observatory, but the maintaining and completing an *old* one, which is admirably equipped with instruments, and requires very little additional personal assistance to double its effectiveness.

We have not had any very recent intelligence from the Cape of Good Hope, but we understand the astronomical observations are proceeding with great activity now that the staff of the observatory are freed from their heavy task of measuring an arc of the meridian. Though we are justly proud of the energy and skill with which, under no common difficulties, this harassing operation has been carried out by Mr. Maclear, we have to regret that the effect upon his health has been exceedingly injurious, and that the fatigue and anxiety attending his exposure and responsibility have brought upon him the signs, and we fear some consequences, of premature age.

To the ninth volume of the *Monthly Notices*, Mr. Maclear has contributed a most accurate catalogue of southern stars, suspected by Professor Mädler to have large proper motion; and also a

singularly full and complete series of observations of Wilmot's Comet. Another series, equally full and complete, of observations of the interesting double comet of Biela, will be found in the first number of the volume in progress. It is necessary to examine these memoirs closely to become aware of the enormous quantity of labour which they so neatly represent. Our anxiety, with respect to Mr. Maclear, is only as to his health ; if this be satisfactory, we feel assured of his astronomical activity and capacity.

An equatoreal by Merz and Son of Munich, precisely similar, we believe, to that possessed by Mr. Dawes, has recently been forwarded by the Government to the Cape Observatory, and has arrived *safely*. This is not an unnecessary announcement, for the package had been opened at the English custom-house, and the screws were not replaced in repacking it.* Mr. Maclear has already applied this instrument to some of the more interesting double stars, and communicated the general result to Sir John Herschel. Thus the binary nature of γ *Coronæ Australis* is confirmed, γ *Antares* is seen as a double star admitting of measurement, α *Centauri* goes on steadily in its orbit, and p *Eridani* has advanced 30° 35′ since Sir John's measures.

Since the last Anniversary, the first of the annual visitations of of the Edinburgh Observatory has taken place, and the Report presented by the Astronomer on that occasion, and approved by the Visitors, having been printed and extensively circulated, need not be specially alluded to here. As to subsequent matters, we may mention that another volume of Observations has appeared—the eighth, or that for 1842 ; and another, that for 1843, has been completed for some time in manuscript, and the printing is so far advanced, that it will probably be finished in a few weeks. The computations for 1844 have been commenced, and that being the last year of the arrears of observations, Professor Piazzi Smyth has inserted in the ninth volume a programme of his own intended course of observation, and the reasons upon which it is founded. These are essentially the same as those contained in a paper read before the Royal Society of Edinburgh in 1847, and alluded to in our Annual Report for the same year. Both the mural circle and the transit instrument are now in complete working order. Observations have been commenced with them, and the reductions are carried on, as far as possible, simultaneously with them.

The history of the Liverpool Observatory will be found in the volumes of the *Monthly Notices*, and the observations of the minor planets are the most satisfactory proofs of its power and efficiency. Any one acquainted with practical astronomy will see at once that

* The necessity of unpacking the instrument at all is not very obvious. There are surely no duties to be paid in London when London is merely a port of transit. At any rate the carelessness which endangered a manifestly valuable and delicate instrument was quite inexcusable, and that it was destined for a government institution does not diminish the culpability.

such observations would do credit to any observatory and any instrument. The labour must not be estimated by the *space* which these observations occupy, a single line may compress the bodily toil of a night and the computation of a day. To estimate this properly a person should see the observations made, and go over the reductions. It must, too, be remembered that the astronomical observations published in the *Monthly Notices* are merely the bye-work of the Liverpool astronomer. His special duty is to time and rate chronometers for the port of Liverpool, a duty which is performed with the most scrupulous accuracy, and we trust with increasing advantage to navigation.

Mr. Hartnup has undertaken to assist Professor Bond in determining the difference of longitude between Boston and Liverpool by chronometer; and several passages between the two ports have been made in the course of the year.

Those who have read the account of the longitude of Valentia by the President will acknowledge that the English end of the arc could not be in better or more experienced hands than Mr. Hartnup's.

In the course of last year a volume has been published, containing "*Results of Astronomical Observations made at the Observatory of the University*, Durham, *from* January 1846 to July 1848, *under the direction of Professor the* Rev. Temple Chevallier, F.R.A.S., *by the* Rev. R. A. Thompson." These consist of observations of 298 stars; of a considerable series of the right ascensions of the moon's limbs, with the corresponding moon-culminating stars; of observations of the right ascension and north polar distance of the sun, moon, and planets; eclipses of *Jupiter's* satellites, diameters of the planets, &c. A few of the planetary observations, with the current reductions, have been published from time to time in the *Monthly Notices;* but in the published volume the whole series is given, with the necessary means of verification. There is a full account in the preface of the processes of observing and computing; and the work, which is very neatly and compactly got up, does great credit to the university from which it originates.

From the Madras Observatory we have accounts of active operations under Capt. W. S. Jacob. In the meridian department he is occupied in revising and perfecting the late Mr. Taylor's extensive catalogues of stars. He has likewise selected from the British Association Catalogue all those stars between the limits of 40° and 155° N.P.D. which depend upon only one observer: these are about 1200 in number. *Neptune* he has been observing, and would have observed the other new planets also, but that they are, unfortunately, not within range of the very small object-glasses with which his meridian instruments are furnished. Double stars, especially southern ones, will form a distinctive part of the duties of the establishment; and the Hon. East India Company have, we believe,

with this view lately provided the Observatory with an equatoreal of superior optical power. The instrument had not arrived at the date of the last advices; but when it does, we may look for interesting and important results from so able and zealous a double-star observer as Capt. Jacob has long since proved himself to be, as well as from the comparatively new field in which he will have to work. Pending the arrival of the telescope, he has been employing himself on the orbits of several double stars, and especially on that of *α Centauri*, which he has made peculiarly his own; and as the only other published approximation to an orbit gives 1867 as the date of the peri-astre of the two stars, while he states 1853 as the time of the periastral passage, he has examined the limits of possible error of each of the elements of his orbit, and finds them so very small, as to induce him to look upon it as a well-determined stellar orbit; while, being the closest to us of any, and being seen under the greatest angular dimensions, it merits the closest attention from both observers and computers.

Among other striking proofs of the onward march of science in the western world, the foundation and progress of the Smithsonian Institution deserves particular attention. John Smithson, Esq., of England, left his property in trust to the United States of America, to found at Washington an institution which should bear his own name, and have for its objects "the *increase* and *diffusion* of knowledge among men." This honourable trust was accepted; and an act of Congress, passed August 10, 1846, appointed as trustees and governors the highest official members of the administration, and citizens distinguished for their talents and acquirements.

The institution will consist of a most extensive library and museum, with a gallery of art, lecture-rooms, &c. These are now in progress, and it is expected that after the completion of the buildings there will be left an annual fund of about 40,000 dollars for the purposes of the Society.

It is intended to publish every year a quarto volume of original researches, historical, scientific, &c., in which astronomy and its related sciences promise to bear a conspicuous part. We have already been favoured with a memoir* extracted from the second volume, containing an elaborate inquiry into the elements of *Neptune*, with a very accurate and extended ephemeris of the planet, by Mr. S. C. Walker: several more astronomical papers will be inserted in the volume.

To carry into effect Mr. Smithson's second object, the "*diffusion* of knowledge," the regents of the institution have offered most valuable assistance in facilitating the interchange of transactions and scientific memoirs between the United States and other countries: in no way could the design of the founder be more legitimately and usefully fulfilled.

* Copies of this memoir have been very liberally distributed in this country through the Royal Astronomical Society.

The astronomical expedition sent by the Government of the United States to the coast of Chili, for the purpose of making series of observations on *Mars* and *Venus*, simultaneously with other observations in distant situations, has been already mentioned in the *Monthly Notices*. The difference between the simultaneous determinations will give the parallaxes of the two planets at times when these greatly exceed the parallax of the sun, and from such data it is hoped that the parallax of the sun may be deduced with great accuracy. The instruments for this expedition have been chiefly provided by a government appropriation, but the Smithsonian Institution has lent a valuable achromatic telescope, which has been constructed by an American artist for this special service. Lieut. Gilliss, who commands the expedition, has had great experience in the use of astronomical instruments, and will, undoubtedly, apply himself zealously to his task. The time when the planets are unfavourably situated for the determination of parallax will be devoted by Lieut. Gilliss to other astronomical researches. A very careful programme of the intended series of observations has been published by authority, and numerous copies sent to this and to other countries with a request for co-operation.

The observations for restoring the Standard Yard have been progressing slowly, but on the whole more satisfactorily than in former years. Many of the difficulties have been overcome and others have been palliated. Still the definition of the lost yard, or the construction of *exceedingly* accurate copies, are not by any means very simple problems or such as admit of rapid solution. The observations are made on which the new yard will be based; and though there is a good deal of small computation and correction yet to be done, much is already done, and no difficulty is foreseen. When the Committee have decided upon the relation of a certain measure, set off upon a new bar, to the lost standard, the multiplication of copies will be neither very tedious nor difficult. The apparatus is convenient and manageable. The only points in which improvement seems to be required, is in the finish of the divisions and the mode of illuminating them. Perhaps the microscopes admit of some change for the better in their optical part; but as matters are now, there is, it is believed, no doubt as to the great superiority of the measuring apparatus at present employed above anything of a similar nature used previously.

This is, perhaps, a proper occasion on which to invite the assistance of all gentlemen who are accustomed to make exact micrometrical measures. The present observer is not able to make many continuous observations, from weakness of eye, neither are the single bisections quite so good as they might be and ought to be. But besides this, it is known by actual experiment, that different persons disagree, and sometimes greatly disagree, in their estimation of a bisection. Thus the length of the lost standard was 0·0003 inches longer by one person's measurement than by another's; nay, was, when reversed, of a different length to what it was before,

by the same person's measurement. There is no error of any such amount to be feared in the new standard; but it is impossible to say, without trial, whether there may not be some similar error, depending on the *person*. The observer, therefore, begs earnestly that such Fellows of the Society as have any acquaintance with micrometrical measurements, or who, having good eyes and nice fingers, can give a little time to learn to make such measurements—the simplest and easiest possible—will inform him of their readiness to assist. With a little help of this kind, the work will now go on much more rapidly than hitherto.*

Another planet, named by M. de Gasparis, its discoverer, *Hygeia Borbonica*, has been discovered in that formerly vacant interval between *Mars* and *Jupiter*, now peopled by ten of these small bodies. It seems destined that our ideas of the structure of the planetary system should undergo a great change. It is not strange that planets far beyond the furthest known should, as time advances, be discovered, but it does appear strange that planets and satellites should be discovered intervening between those formerly known. And we may well doubt whether there are not planets whose orbits lie between those of *Venus* and the Earth, and whether that body which we call the moon is the only satellite of the Earth. The importance of these discoveries is not to be judged of as merely a matter of detail, in which new particulars are simply added to old ones of the same class. Our conceptions of the structure of our system in particular, and of the sidereal system generally, may ere long be totally altered by the discovery of the almost universal prevalence of planetary and cometary bodies through all the space which our instruments command.

The past year has added two new Comets to our list, both detected in the month of April. The first was found on the 11th by M. Schweizer at Moscow, and a few hours later by Mr. G. P. Bond, at Cambridge, U.S. It was also discovered independently by Mr. Graham, at Markree, on the 14th. It was tolerably large and bright when viewed in the telescope, but barely visible to the naked eye. The orbit does not appear to differ sensibly from a parabola, this curve satisfying the observations within their probable limits of error, and better than any ellipse. The conjecture as to the identity of this comet with the second of 1748 is, therefore, inadmissible.

The second comet was detected by M. Goujon, at the Observatory of Paris, on the night of April 15. It was not visible without optical aid, but remained in sight to the large telescopes at the command of several of our Fellows until the latter end of September. It has no resemblance to any of the comets previously calculated. The whole course of observations is perfectly represented by a parabolic orbit.

* An Arnott's stove has been recently fixed in the observing vault; and it is intended to keep the temperature at a *comfortable* point.

The disappearance of *Saturn's* ring, which had occurred before the Anniversary Meeting of last year, and which enabled Mr. Bond and Mr. Lassell to discover a new satellite, gave also the opportunity of making many other physical observations on that remarkable planet. Among these, the Council attach a high value to the micrometrical measures of different diameters of the planet, made at the Royal Observatory by the Rev. R. Main, first assistant in that establishment. Judging by the eye only, Sir W. Herschel conceived that the form of the planet deviated from the elliptic spheroid by considerable protuberance at middle latitudes. The Astronomer Royal, in a paper published many years since in the *Cambridge Transactions*, showed that such a form could not be explained by the attraction of the ring. Mr. Main's measurements have shown beyond doubt that the form of the planet does *not* differ from that of the elliptic spheroid; and the Council have the very great satisfaction of stating that Sir John Herschel, with his usual frankness, has communicated to Mr. Main his avowal that Mr. Main's observations are perfectly decisive on this point, and that there cannot remain the smallest reason for suspecting the existence of this anomalous form.

Among the official astronomical publications of the British Government, the Council wish to call the attention of the Society to the printing (now almost completed) of the results of the first accurate observations made at the Cape of Good Hope by Mr. Fallows, in the years 1829, 1830, 1831. In the confusion of all kinds attending the decease of the first head of an institution like the Cape Observatory, when the troubles attending the mounting of new and imperfect instruments are scarcely surmounted, and when no rule or precedent has been established for the ultimate treatment of the observations, it is not to be wondered at that there should have been delay in the definitive reduction and printing of the first Cape Observations. It is stated by the Astronomer Royal that efforts had, some time ago, been made by the Board of Admiralty for procuring the reduction and exhibition, in a proper form, of Mr. Fallows' observations. They were finally placed in the hands of the Astronomer Royal, who has completed the reductions; and by an arrangement made between the Board of Admiralty and the Council of this Society, the results of the observations in a very detailed form will be published at the expense of the Admiralty in the Society's *Memoirs.* While the Council congratulate the Society and astronomers in general on the preservation of observations which will, probably, be regarded as the foundation of astronomy in the southern hemisphere, and on an act of justice to the memory of Mr. Fallows, they also rejoice to see that another proof has been given that the well-directed acts of the dead do not die with them, and that the astronomer who, under difficult circumstances, steadily and conscientiously labours at the work which his position prescribes, may be assured that his successors, if not his contemporaries, will set the proper value upon it;

and that the publicity which he may not live to see will assuredly be given to it at some later time.

The gigantic instrument of the present day, and that by which this period will, perhaps, be most distinguished to future ages, is Lord Rosse's 6-feet reflector. In successive communications made to the Society by the Astronomer Royal, which are printed in great detail in our *Monthly Notices*, information has been given to the Society of the powers of this instrument, and of the difficulties and the successive steps of improvement in its mechanical arrangements. In the last of these communications the Society will have had the satisfaction of learning that the mounting now adopted for the mirror appears to be perfect; and we may hope before long to learn the results of these observations of the most difficult class, for which extreme beauty of definition, as well as great light, are necessary.

The method of treatment of the observations of double stars for the determination of their relative orbits has been put by Sir John Herschel into a most elegant form, in which, perhaps, the graphical and the algebraical parts are more clearly distinguished than they had formerly been. Accompanying Sir John Herschel's communication were notes from M. Yvon Villarceau, of the Observatory of Paris, containing explanations of a method in some respects similar to Sir John Herschel's, with applications of it to some of the most remarkable double stars. In these notes, M. Yvon Villarceau has not contented himself with investigating orbits, but has shown that, even after discussing large masses of the best modern observations, the elements of the orbit may be indefinite, and that nothing but observations at a distant time can successfully be used for removing this indefiniteness In alluding to this subject, the Council must not omit to state that M. Yvon Villarceau, in a communication to the French Institute, has very carefully discussed the evidence for the applicability of the law of gravitation to the relative motions of double stars (which, undoubtedly, has been assumed rather hastily). His conclusion is, that the evidence does not authorise us to say that it is certain that this law applies to the double stars, but only that it is probable.

The allusion to a subject, in which the value of the observations depends on the accuracy of the micrometrical measures, suggests to the Council the remarks made by Mr. Hind on the discordance in the measures of the distance of *Neptune's* satellite, and the great effect which it produces in the resulting mass of that planet. Remarking the great importance of that mass in reference to one of the most interesting problems in physical astronomy that the world has ever known, the Council express their earnest hope that the doubt may be removed, by numerous and careful measures, made by those persons who possess the instrumental means required for them.

A valuable paper on Irradiation has been presented to the So-

ciety by Professor Powell. The Council attach great importance to every investigation applying to those optical circumstances which affect observations (so to speak) in their very birth, and whose effects cannot be removed by any subsequent treatment. They wish to apply the same expressions to the investigation by Professor Challis (which has lately reached them), on the method of correcting the errors of transits for the effect of erroneous form of the pivots.

One of the last communications which has reached the Society is a paper from our esteemed Associate, M. Otto von Struve, on the suspected parallax of the star *Groombridge* 1830. By a most careful series of comparisons in declination with the neighbouring stars, made by means of the micrometer attached to the great equatoreal telescope at the Observatory of Poulkova, M. Otto Struve appears to have proved incontestably that the parallax of this star is totally undiscoverable by the best instrumental means of the present day.

A series of observations for the same purpose, but with less efficient instruments, was made at the Royal Observatory, and is printed in the *Observations* of 1847. The discussion of these results is not yet published, but it appears that they lead to the same general conclusion as M. Otto Struve's; namely, that the parallax of *Groombridge* 1830 cannot, at the utmost, exceed a small fraction of a second.

Previously to the last Anniversary Meeting of the Society, the new method of observing transits, introduced in America by Dr. Locke and Professor Mitchell (in which the touch of the finger is substituted for the perception of the ear, and the impress of a galvanic magnet upon a sliding piece of paper is substituted for a record in an observing-book), had been communicated to the Society. It has again been brought more prominently before us by the President, in an oral statement, subsequently printed in the *Monthly Notices*, in which the inconveniences as well as the advantages of the method are explained. The Council abstain from pronouncing any positive opinion upon the advantages or probability of universal adoption of this method; but they can have no hesitation in indicating it as one which well deserves the consideration of every director of an observatory.

The department of meteoric astronomy (for the time seems to be arrived, or fast arriving, when we shall be able to use such a term with as little misgiving as we now speak of cometic) has been of late assiduously cultivated by M. Petit, Director of the Observatory of Toulouse, who has communicated to the Academy of Sciences of that city a memoir, which has appeared in their *Transactions*, on the determination of the orbits of meteors, not only relatively with respect to the earth, but absolutely with reference to the sun. This memoir contains formulæ applicable to all cases

where observations thoroughly to be depended on are procured. The meteor of the 19th August, 1847, fortunately afforded such observations; and in a letter recently addressed by him to M. Schumacher, and published in the *Astronomische Nachrichten*, No. 701, he states the following extraordinary and highly interesting result of his calculations:—

The meteor, when first seen, was at a distance from the earth's surface = 217900 metres, and when lost sight of, 68900. Its relative velocity with respect to the earth was 41700 metres per second, and its absolute velocity in its orbit about the sun, 70094. At the moment of its first apparition it was in the act of describing a hyperbolic orbit about the sun, having for perihelion distance 0·9783952, and a semiaxis of — 0·2385498, with an excentricity, node, and inclination ascertained by M. Petit, but of no immediate interest. But since at that instant it had already undergone some effect of perturbation, both by the earth and moon, M. Petit has computed and allowed for that effect, and concludes that previous to entering the sphere of the earth's appreciable action its orbit was hyperbolic, with an excentricity 3·95134, perihelion distance 0·95626, and semiaxis — 0·32401. This meteor, therefore, must have come from the regions of space exterior to our system, and the epoch at which it must have quitted a sphere having a radius of one parallactic unit (or the distance of a star whose annual parallax = 1″) must have been no less than 373397·7 years antecedent to that of its arrival at its perihelion in 1847. This interesting body would appear, from M. Petit's calculations, to have fallen into the North Sea near the Belgian coast.

The volume of *Greenwich Observations* for 1847 (long delayed for the sake of its Appendix) has, within a few months, been published; and the Council think it worthy of special notice, on account of some important novelties. Of these, the first is the publication, in a very complete form, of the observations of the first six months with the Altitude and Azimuth Instrument—a series which, assisted by the elaborate plans and explanation of the construction of the instrument, as well as the explanation of the mode of using it, may tend to give a strong impulse in favour of the adoption of that most valuable construction. The second is, the extensive Catalogue of Stars, deduced from all the observations made at the Royal Observatory from 1836 to 1847, but printed in a form which admits of the division of these observations into two groups of six years each, accompanied with day-numbers to the end of 1860, and star-numbers for all the stars, computed in accordance with the principles of a paper printed in the *Memoirs* of this Society, the object of which was to show that star-reductions might be computed without any quantities changing their algebraical signs. The possible advantages of such a method are, of course, purely practical; but the importance of getting rid of changes of sign is recognised by every practical computer.

Mr. Bishop hopes to complete the greater number of his ecliptical charts during the present year. The delay in their publication has arisen partly from an extension of the original plan, and partly from Mr. Hind's indisposition during the last summer. It had been proposed by Mr. Bishop to insert all stars of the *eleventh* magnitude within the limits of the map; but, to do this effectually, it was found that a much longer period would be required than if the charts were to contain stars to the tenth magnitude only. Mr. Bishop therefore intends to continue his maps on the same plan as that for Hour I., already published, which includes all stars to the tenth magnitude within 3° of the ecliptic.

Among matters of unusual astronomical interest connected with the past year, must be classed the publication of Sir J. Herschel's *Outlines of Astronomy*. It would at this moment be difficult to name a science the truths of which have been expounded to the world in so remarkable a manner, by combination of profound knowledge and power of writing with unusual opportunities of observation and of authentication. If many had enjoyed such opportunities, it would be the universal opinion that no one should write on astronomy at large who had not laboured in both hemispheres; and though the rarity of such instances makes such a restriction impossible, it enhances the value of the work now alluded to, which must long remain the most complete and most satisfactory exhibition of the science, as a whole, to the educated world, as well as a valuable manual of thought to the professed astronomer.

Among the auxiliaries which enable astronomical observations to be transformed into practical results, logarithmic tables occupy a prominent place. Capt. Shortrede, of the East India Company's service, and a Fellow of this Society, has, at an expense which would have fitted up an observatory, and with as little chance of pecuniary profit, and much personal labour, edited the largest set of logarithmic trigonometrical tables that has hitherto appeared in this kingdom. The composition and stereotyping of this work were executed at Edinburgh, and a small edition was issued in 1844, in one volume, while the author was yet in India. Some defects of execution having appeared, Capt. Shortrede, on returning to England, caused most of these copies to be cancelled; and after a thorough revision of the plates, and a recast of some of them, he returned to India early in last year, leaving directions that the trigonometrical part of the tables should be published separately. The part alluded to contains the logarithmic sines and tangents for every second throughout the quadrant, comprised in less than one-third of the bulk of Mr. Michael Taylor's volume. The principal feature of the other portion of the work consists in exhibiting, in a symmetrical form, the numbers answering to given common logarithms — a form which, in certain calculations (not astronomical) possesses advantages over its ordinary converse. As originally constructed by Dodson (1742), it was inconvenient for modern use, and had

also become scarce. The work likewise presents tables upon a new and facile principle, for obtaining logarithms to numbers, and *vice versâ* to a large number of places. In the constructing and perfecting of these, two other of our Fellows (MM. Gray and Weddell), with Mr. Hearne of Sandhurst, have had a chief share. From some cause not explained, Capt. Shortrede's tables, though completed at press several months since, have only recently been obtainable in London. The author has fixed a price for the copies barely equivalent to the paper and press-work. The Council feel assured that his public-spirited munificence will be appreciated by astronomers, and that this Society will, in particular, enrol him among the benefactors of the science.

Titles of Papers read between Feb. 1849 and Feb. 1850.

1849.

Mar. 9. Elements of *Iris*. Mr. Pogson.
Various Observations. M. Rümker.
Observations of the Satellite of *Neptune*. Professor W. C. Bond.
Observations of Planets. Professor Chevallier.
On the Discovery of an Eighth Satellite of *Saturn*. Mr. Tuckett.
On the Longitude of Hobarton. Captain Shadwell.
On a new Method of observing Transits. Professor Bache.
Observations of Solar Spots. Mr. Lowe.
Observations of Satellites of *Saturn*, *Uranus*, &c. Mr. Lassell.
Description of a Perpetual Calendar. Captain Shortrede.
On Irradiation. Professor Powell.
Observations of *Neptune*. Mr. Cooper.
Observations of *Iris*. Mr. Boreham.
Ephemeris of *Iris*. Mr. Pogson.
Observations of *Neptune* and *Iris*. Mr. Hartnup.
Observations of Solar Spots. Captain Shea.
On a Formula in Interpolations. Rev. R. Sheepshanks.
Elements and Ephemeris of Petersen's Second Comet. M. Rümker.
Remarks on the Chronology of Lunations. Mr. Lowe.
On the Form of the Planet *Saturn*. Rev. R. Main.
On an Occultation during Lunar Eclipse, March 8, 1849. Mr. Chalmers.
Notice of Optical Glass. Mr. W. Simms.

April 13. On the Aurora of November 17, 1848. Sir A. Lang.
Observations of Petersen's Second Comet. Messrs. Cooper and Graham.

1849.

April 13. D'Arrest's Elements of Petersen's Second Comet. Professor Schumacher.
Observations. M. Rümker.
Elements of Petersen's Second Comet. Mr. Safford.
On the Lunar Eclipse of March 8, 1849. Mr. Hind.
On the Lunar Eclipse of March 8, 1849. Professor Challis.
On the Astronomer Royal's Method of ascertaining the true Diameter of *Venus*. Rev. R. Sheepshanks.
On the Determination of the Orbits of Binary Stars. Sir J. Herschel.
Observations of Solar Spots. Captain Jacob.
On an Adaptation to the Eye-piece of a Telescope. Rev. J. B. Reade.
Appendix to Sir J. Herschel's Paper. The Astronomer Royal.
On Calculating the Moon's Place for Ephemerides. Mr. Drach.
Facts bearing on Irradiation. Captain Shortrede.
Observations of Wilmot's Comet. Mr. Maclear.

May 11. Observations of *Iris*. Mr. Hartnup.
Orbits of Double Stars. Mr. Hind.
Discovery of a Comet, Observations and Orbit. Mr. Graham.
On a new Comet. Professor W. C. Bond.
Circular respecting new Comet. Professor Schumacher.
Ephemeris of *Metis*. Mr. Gould.
Observations of Satellites of *Saturn*. Mr. Lassell.
Ephemeris of *Metis*. Mr. Graham.
On Rating Chronometers at Sea. Mr. Toynbee.
Observations of *Flora*. Mr. Hartnup.
Ephemeris of *Flora*. Dr. Brünnow.
On Schweitzer—Bond's, and Goujon's Comet. Professor Schumacher.
On the Solar Spots. Lieut. Hardy.

June 8. Note on the Mass of *Uranus*. Mr. Adams.
Ephemeris of *Iris*. Mr. Pogson.
Observations of *Flora*, &c. Mr. Hartnup.
On the intended Chronometric Junction of Boston and Liverpool. Professor W. C. Bond.
Observations and Elements of Schweitzer's Comet. Professor W. C. Bond.
Circulars on Schweitzer's and Goujon's Comets, &c. Professor Schumacher.
Observations of De Gasparis' Planet. Professor Schumacher.
Ephemeris of De Gasparis' Planet. Mr. H. Breen.
Observations of De Gasparis' Planet. M. Rümker.
Observations of De Gasparis' Planet. Mr. Hind.

1849.

June 8. Ephemeris and Elements of *Metis*. Mr. Graham.
On the Discovery of De Gasparis' Planet. M. Cappocii.
Description of a Transit Room. Mr. Dell.
Diagrams of Solar Spots. Captain Jacob.
On Double Stars. M. Villarceau.

Nov. 9. Observations. M. Rümker.
Observations. Mr. Hartnup.
On an Improved Compensation Balance. Mr. Hartnup.
Ephemeris of *Metis*. Mr. Graham.
Note on Brorsen's First Comet, 1846. Mr. Hind.
Observations of *Hygeia*. M. Scarpellini.
Observations of *Hygeia*. M. Santini.
Note on the Mass of *Neptune*. Mr. Hind.
Note on Polishing Specula. Mr. Lassell.
On the Fourth Satellite of *Saturn*. Mr. Lassell.
Observations of Goujon's Comet. Mr. Boreham.
Ephemeris of Goujon's Comet. Mr. Pogson.
On a new Term in the Lunar Theory. Professor Hansen.
Observations of Goujon's Comet. Mr. Lassell.
Observations of Comets. MM. Cooper and Graham.
Observations of Goujon's Comet. Mr. Lassell.
Ephemeris of *Hygeia*. Mr. Graham.
Ingress of *Mercury*, Nov. 9, 1848. Mr. Luff.
Observations of Planets and Comets. Mr. Hartnup.
Observations of Gambart's Comet. Mr. Maclear.
Observations of *Metis*. M. Rümker.
Ephemeris of De Vico's Comet. Professor Chevallier.
Notices of *Saturn*. Mr. Bond.
Ephemeris of *Metis*. Mr. Graham.
Notice on Falling Stars. Mr. Lowe.
On the Anglo-Saxon Yard. Mr. Wackerbarth.
Account of a Meteor. Mr. Webb.
Occultations observed at Ashurst. Mr. Snow.
Ephemeris of *Metis*. Mr. Graham.
Observations of Goujon's Comet. Mr. Lassell.
Observations of *Metis*. M. Rümker.

Dec. 14. Observations of Stars compared with Goujon's Comet. Mr. Hartnup.
Diameters of *Venus*. Mr. Lassell.
On a Calculating Machine. Mr. Drach.
Diameters of *Venus*. Mr. Hartnup.
On Lord Rosse's great Reflector. Mr. Airy.
On Mr. Bell's Calculating Machine. Mr. Airy.
On Lunar Tables. Mr. Drach.
Observations of *Metis*. Mr. Hartnup.
Observations of *Neptune*. Mr. Hartnup.
On Correcting the Errors of Pivots of Transit Instruments. Professor Challis.

1849.

Dec. 14. On the Appulse of *Jupiter* and the Moon, Dec. 7, 1849. Captain Shea.

1850.

Jan. 11. Errors in Shortrede's Logarithms, second edition. Mr. Gray.
Various Observations. M. Rümker.
Observations of *Neptune* and *Metis*. Mr. Hartnup.
On a new Method of Mounting an Equatoreal. Mr. Cowper.
On *Saturn's* Ring. Rev. R. Dawes.
On the Construction of an Observatory. Mr. Drew.
On a Spiral Calculator. Rev. T. P. Dale.
On a Speculum Polishing Machine. Mr. Hippisley.
On Halley's Comet, &c. Mr. Hind.

List of Public Institutions and of Persons who have contributed to the Society's Library, &c. since the last Anniversary.

Royal Society of London.
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Royal Irish Academy.
Hon. East India Company.
Royal Geographical Society.
Geological Society.
Royal Asiatic Society.
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Zoological Society.
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L'Administration Impériale des Mines de Russie.
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Executors of the late Father De Vico.
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M. F. G. W. Struve.
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Mr. J. Williams.
J. W. Woollgar, Esq.

Address delivered by the Astronomer Royal, President of the Society, on presenting the Honorary Medal of the Society to M. Otto von Struve.

It has been stated to you, Gentlemen, in the Report of your Council, that the Medal of the Society has been awarded to M. Otto von Struve, for his paper entitled, "*Bestimmung der Constante der Präcession mit Berücksichtigung der eigenen Bewegung des Sonnensystems*," communicated to the Academy of St. Petersburg on the 19th of November, 1841, and printed in the third volume of their *Mathematical and Physical Transactions*, sixth series; and it is now my most agreeable duty to point out to you the state of the questions to which this paper relates, the need for a new investigation, the skill and care with which M. O. Struve's investigations have been conducted, and (in a word) the claims which the selection of the subject and the mode of treating it have presented for the honourable notice of the Society.

The subject of precession, generally, has always appeared to me one of the highest interest in physical astronomy. Its discovery, as an astronomical fact, dates from the earliest age of scientific astronomy. Its existence was recognised, and its quantity tolerably well measured, by the astronomers of the succeeding ages. But century after century rolled away, and no human being entertained the smallest idea of its cause. It stood as an anomalous fact, perfectly certain in its existence, perfectly clear in its law, but unconnected in its form, or in its probable causes, with any other phenomenon known to man. The establishment of the Copernican theory did not appear likely to aid at all in its explanation. Vortices might be conceived which would carry planets round the sun, but no vortex was devised which could give to the earth's axis the gradual change of position required to explain the fact of precession. At length Newton,—thoroughly imbued with the knowledge of the Galilean mechanics, powerful in the use of the new calculus which he had already invented, ready to invent newer methods whenever they should be required,—examined in a mechanical point of view the principal laws of the planetary motions, and the principal perturbations of the moon, and explained them fully by his theory of gravitation. But a part only of the theory was required in these explanations. It sufficed, in regard to the attractions, to consider the attraction and the liability to attraction, of every body in the solar system, as being fixed in its centre. It sufficed, in regard to the laws of mechanics involved in the investigation, to consider the moving bodies as points. Had Newton stopped here, the explanations of precession, of the figure of the earth, and of the tides, would have been lost. At this distance of time I cannot refuse my admiration to the generality of conception which suggested to him that the centre of a planet can have no special virtue, except from the combination of the actions of all its parts, nor to the undeviating firmness with which he retained this conception, nor to the mathematical sagacity with which he perceived that one of the consequences of this conception must be an ample explanation of precession and the related phenomena. But in what form was this explanation to be put? At the present time, the explanation of precession, from its mechanical causes, in a form which shall be extensively intelligible, is one of the most difficult practical problems that I know. In the first place in which Newton treats of it, he derives its explanation, by a very simple analogy, from that of the motion of the plane of the moon's orbit; and I believe that this is still the easiest illustration that can be offered. In the second place, where he makes it a matter of calculation, he abandons that form, and treats it (as it ought finally to be treated) as a case of the theory of rigid bodies. A small error was made in this theory; but it was unimportant. Regarding its object as being this, to show that the phenomenon, generally, was explained, and that its magnitude was computed as nearly as could be expected, it was perfectly successful. And I have no hesitation in expressing my belief that, if I had lived in

that critical time of science, the explanation to which I should have appealed as establishing the truth of the theory of gravitation, would have been the explanation of precession.

Among the applications of our knowledge of precession, the most striking, perhaps, to ordinary imaginations, is that which connects it with the broader and coarser features of very ancient chronology. The stars over which the colures have passed in succession, as one century after another has slipped away, may well be described in the words of a modern poet, applied to a different kind of memorial,—

> "Like dials, which the wizard Time
> Had raised to count his ages by."

In some instances, undoubtedly, this use of the theory has been abused; in all it is liable to considerable uncertainty. Nevertheless, it is one which sometimes gives us information when all other sources fail. And nothing appears more marvellous than that it should be possible, from a single well-authenticated shepherd's observation of the heliacal rising of a star, to infer the date with a precision much exceeding that of many of the records of history.

To the practical astronomer, however, of the present day, the exact knowledge of the law and magnitude of precession is more necessary for another reason. Not a single observation can be properly reduced, not a clock-error can be investigated, not a place of sun, or moon, or planet, or comet, can be brought to a state in which theory can be confronted with observation, without an accurate knowledge of precession. And it is this, in fact, which has given rise to the necessity for repeated investigations of the numerical value of the constants of precession.

In this, as in all other cases of natural philosophy, the more the accuracy of observations is increased, the greater becomes the complexity of the laws of nature which it is necessary to take into account; and the investigation, which at first was intended only for the purpose of correcting the numerical coefficients of a known theory, may lead to the discovery or verification of a subordinate theory of a totally different kind. We shall find that this very circumstance occurs in the investigation which is now before us.

The determinations of precession to which, by common consent, the astronomers of Europe had referred before M. O. Struve's investigation was undertaken, and which, in fact, are most generally used at the present time, are Bessel's. They were made at two successive steps. The first of these is detailed in the "*Untersuchung der Grösse und des Einflusses des Vorrückens der Nachtgleichen*," a paper honoured with the prize of the Berlin Academy; its last alterations are dated 18th August, 1815. The subject of precession is treated in this paper by a comparison of Bradley's places of 2429 stars in north polar distance, and 2278 stars in right ascension, with the places in Piazzi's two catalogues. It is needless for me to trouble you with details of the division of the heaven into

zones, and of the subdivision of each zone into portions, or of other devices suggested by the author's well-known skill. But it is important to remark that Bessel fully recognised the difficulties introduced by the proper motions of the stars and the probable movement of the solar system, and that he pointed out a certain degree of regularity in the discordances of results, which however, in his opinion, was not at all favourable to Sir William Herschel's supposition that the motion is directed towards the constellation *Hercules*. These difficulties he hoped to overcome by using for the comparison a large number of stars. He also remarked critically on the possible errors of Piazzi's catalogue, as inferred from his discordant determinations of the obliquity at the two solstices, and on the effect of those errors. And he treated the immediate results of his investigation with due reference to the difference between general and luni-solar precession, and founded upon that difference deductions as to the mass of *Venus*.

In the Berlin *Memoirs* for 1818–1819, Bessel gave his catalogue of 36 stars, founded upon his own observations and his own determination of the equinoxes, using Von Lindenau's new coefficient of nutation in the reductions. In the *Memoirs*, 1825, he gave new determinations of right ascension of the same stars, founded on observations made with his new meridian instrument. And in the *Astronomische Nachrichten*, No. 92, he brought together these results, compared them with those which would have been obtained from Piazzi's catalogue if corrected by Von Lindenau's nutation, and used the comparison to correct the coefficients of precession found in the first investigation. And these corrected coefficients are those used in the *Tabulæ Regiomontanæ*, and usually referred to as Bessel's coefficients.

It will be seen from the account which I have given that, though the first determination was made by means of 2400 stars, yet the places at one end of the period are, in fact, carried on by the observations of thirty-six stars; and that the determination is sensibly affected by the use of a coefficient of nutation now generally allowed to be erroneous.

Some time after this, the attention of astronomers was drawn pointedly to the theory of the proper motion of the solar system. The first enunciation of this theory had been given by Mr. Herschel (afterwards Sir William Herschel) in the *Philosophical Transactions*, 1783. In the first place, he had taken Dr. Maskelyne's proper motions of *Sirius*, *Castor*, *Procyon*, *Pollux*, *Regulus*, *Arcturus*, and α *Aquilæ* (all in right ascension, and *Sirius* and *Arcturus* in polar distance), and had shown that all these motions are explained by a motion of the solar system towards *Hercules*. He then took twenty-seven proper motions, given by Lalande for fourteen stars, and showed that twenty-two of them are explained by motion towards λ *Herculis*. He then took forty-four different stars from Mayer, and showed that the proper motions of thirty-two of them agreed with the same hypothesis. In the *Philosophical Transactions*, 1805, he again took up this subject, and he investi-

gated the pole of intersection of the apparent paths of several pairs of stars. But the most remarkable evidence which he found for his conclusion was thus obtained. The sum of the annual apparent motions of *Sirius*, *Arcturus*, *Capella*, *α Lyræ*, *Aldebaran*, and *Procyon*, was found to be 5″·35. But supposing that the movement of the solar system is towards a point, R.A. 245° 52′ 30″, N.P.D. 40° 22′, and supposing that so much of the proper motions of the stars as is directed towards that point is entirely due to solar motion, then the sum of the residual proper motions is only 0″·96.

It is unnecessary for me to say at length how this theory was supported by some astronomers, as Prevost and Klügel, and how it was doubted by others, as Maskelyne, Burckhardt, and Von Lindenau. Bessel, in the 12th section of the *Fundamenta* (published in 1818), gave a series of numbers defining the directions of the proper motions of seventy-one stars (including all the stars of the *Fundamenta* whose proper motion amounted to 0″·5 annually), and simply remarked on these that they did not confirm Herschel's theory. No important addition was made to the investigation until Argelander took it up, in a paper communicated to the Academy of St. Petersburg in 1837, and printed among their *Divers Savans*, tom. iii. The foundation of this investigation was Argelander's own admirable catalogue of 560 stars for 1830 (published in 1835), and the proper motions which accompany it. Of these 390 were ound available for his purpose. He proposed to treat these proper motions by the method of minimum squares; and the first question was, What ought to be selected for the nature of the residual error, the sum of the squares of which for all the stars should be minimum? The quantity which he adopted was the angle (expressed in degrees not numerically exceeding ±180) between the direction of the star's proper motion and the great circle connecting the star with the pole of solar motion, multiplied by the sine of the star's distance from that pole, without any reference to the amount of the proper motion or to the star's brightness. The result, corrected for some errors, is given in the *Astronomische Nachrichten*, No. 363, the place of the pole of solar motion is found R.A. 259° 52′, N.P.D. 57° 31′. Lundahl (*Astron. Nach.* No. 398), by an application of the same method to a comparison with 147 of Pond's catalogue of 1112 stars, which had not been included in Argelander's catalogue, found results considerably different, especially in declination. It is proper to state that Mr. Galloway, in a paper printed since the appearance of that which is the subject of our medal, has applied Argelander's method to the southern stars; his resulting R.A. is greater, and his N.P.D. less than Argelander's.

The state of the matter when M. Otto Struve undertook his investigation may now be well understood. The determination of precession, though undoubtedly good, admitted probably of improvement. A new element of reduction had attracted general attention; the evidence for its existence, with elements expressible numerically by a measurable or definable quantity, had become too

strong to be neglected ; at the same time that the form of the latest investigations, founding their measures of error on circular angles, and omitting absolutely the consideration of probable distance, might not be satisfactory to every investigator.

The difficulties of this investigation, when fully considered, are almost bewildering. So long as we conceive any one material body to be fixed, our notions of motion, whether of translation or of rotation or revolution, are perfectly clear; but when once we give up the idea of material immobility, we soon perceive that the notion of a zero, either of linear measure or of angle, is a purely metaphysical conception. In applying it to nature we must assume something as arbitrary.

The stars used by M. Otto Struve are 265 double stars, and 74 pairs of stars too widely separated to be included under the same term, of which the right ascensions and north polar distances had been observed by M. Struve at Dorpat: Maskelyne's 36 stars (some of which are included in the former list); 42 circumpolar stars, which had been repeatedly observed with reference to the theory of refraction ; and 39 stars not included in either of these lists. The whole number is 400. The places of the stars are not reduced to one epoch, but each star is reduced to the beginning of that year which corresponds most nearly with the mean of its times of observation, Argelander's proper motions being applied as far as they go, and in some other instances proper motions deduced from a first approximate comparison with the *Fundamenta* being applied. The daily reductions of the star-places were made by means of the numbers in the *Tabulæ Regiomontanæ*. The clock-errors were obtained from the fundamental catalogue in the introduction to the *Dorpat Observations*, vol. vi., the place of the equinox being there determined by 216 observations of the sun distributed over eight equinoxes. Ample proofs are given by Mr. Otto Struve of the accuracy of his individual results. The only possible objection which could be advanced to these determinations for the second of the epochs of comparison, is the preponderance of double stars, whose proper motions, in general, follow peculiar laws. Of those here used, however, the vast majority, without doubt, are only optically double, and no such objection applies to them. And in every other respect the accuracy of the determinations is probably equal to that of any mass of star-places that has ever been collected.

The geometrical annual precessions were then computed for every star for three different epochs, namely, Bradley's epoch, 1755 ; O. Struve's epoch (which, as is mentioned, is different for different stars); and for the epoch half way between them. An approximate formula founded on these gave with facility the whole geometrical precessional motion, accurate to the third power of the time. The comparison of this with the difference between Bradley's and O. Struve's catalogue, gave the proper motion affected by the errors of precession.

And now the metaphysical difficulty to which I have alluded

comes into play. M. O. Struve, in the first portion of the investigation, eluded a part of the difficulty by assuming as established that the solar system does move towards the point finally indicated by Argelander. Still we have not delivered ourselves from difficulties. The zero of angle in the celestial sphere will evidently change according to the magnitude which we attribute to the apparent motions of stars right and left of that pole of the sun's motion, so far as the apparent movement of the stars depends on the sun's motion. What law applying to these parts of the star's apparent movement,—or, in other words, what law of the distance of the stars,—shall we assume? After showing that the proper motions are really (upon the whole) largest for the brightest stars, M. O. Struve finally determines on adopting the law of distance, as connected with magnitude, given by M. Struve in his introduction to the *Catalogus Novus*. I fully agree with Mr. Main (to whom the Council are indebted for a critical abstract of M. O. Struve's paper), that M. O. Struve has omitted some important criteria of distance, namely, the binary nature of the double stars and the amount of proper motion. And at the same time I agree with Mr. Main's further remark that, under all circumstances, there was nothing better to be done for the mass of stars than to adopt the rule which M. O. Struve has adopted. For the stars of less brightness, the stars of one magnitude are assumed to be at one distance; but the stars of the first magnitude are subdivided into several groups of distances. After all, M. O. Struve has thought it necessary to exclude seven small stars of extraordinary large proper motion, as either having peculiar movements in space too large to be tolerated in such an investigation, or as being much nearer to us than Struve's rule of distances would place them.

Equations were then formed, expressing the numerical discordance of the computed and the observed precessional motion by two symbolical terms: one multiplying a correction of the principal term of precession, the other multiplying a symbol expressing the apparent angular motion of the sun in ten years, as viewed from a fixed star, at the mean distance of stars of the first magnitude, in a direction at right angles to its linear motion. This second coefficient was always affected by the star's assumed distance as denominator.

The equations in this shape, M. O. Struve remarks, would give an overwhelming influence to the bright stars; and, therefore, he reduces their weight by a factor founded on the assumption that the uncertainty on the discordance of the two catalogues for a star of the sixth magnitude is equal to the average proper motion, during seventy years, of a star of the sixth magnitude, and equal to the sun's angular motion in the same time: and he represents the whole probable error, $5''{\cdot}5$, by the square root of the sum of their squares. For stars of other magnitudes he retains the first term unaltered, but increases the second and third in the inverse proportion of their distances; and thus he obtains a larger probable error or a smaller weight for the equations for the near stars.

The selection of this form of equations, combined with one of which I shall speak shortly, amounts to this, that upon the whole mass of stars, as far as we are able to form a conjecture of their positions in space, we assume that the algebraic sum of their movements in space estimated in any one direction = 0, and we also assume that the algebraic sum of the geometrical moments of their motions round any one point = 0.

With the equations affected by these weights, he obtains as result, that Bessel's first coefficient of precession in right ascension ought to be increased by $+1''{\cdot}65$; that his second coefficient ought to be increased by $+0''{\cdot}24$; and that the sun's angular motion in ten years (seen as is above mentioned) is $3''{\cdot}15$.

But when these numbers were substituted in the original equations, so as to exhibit the residual errors, it appeared that the numerical quantity for error of observation was too great. A new assumption was then tried, namely, that the probable error of determination is half the value of average proper motion of a star of the sixth magnitude; and the equations were solved anew. The results were very little altered.

The star-corrections in the original investigation of observed places, it is to be remarked, had been reduced with the tables of the *Tabulæ Regiomontanæ*, and, therefore, with Von Lindenau's nutation. But as the investigations of Busch and Peters had now proved beyond doubt that a value of nutation, somewhat different from those adopted in the reductions for either epoch, was nearer the truth, the proper correction was applied for the change. The final result is, that the coefficient of general precession is $50''{\cdot}235$.

And, adopting $0''{\cdot}2$ as the annual parallax of an average star of the first magnitude, the sun's annual motion is found to be $1\frac{1}{2}$ times the radius of the earth's orbit. This linear motion appears to be less than that of stars in general.

M. O. Struve then enters into an investigation of the correction of Argelander's point, by finding symbolically the variations of the expressions for the effect of solar movement, as depending on the variation of the right ascension and polar distance of that point; the numerical value already found for the quantity of solar motion, and the proportion of distances of the stars, being adopted as known elements. The quantity which is exhibited as error, to be reduced by the method of least squares, is the amount of proper motion in right ascension and in polar distance yet to be explained. The weight given to each equation is the same as that in the former investigations. A point is thus found, several degrees north of Argelander's final point, and having greater right ascension, but not very distant from that first found by Argelander. This investigation appears to me the most satisfactory that has been made. But another investigation, which is subjoined to it, tends in no small degree to injure the credit of this and of every other investigation directed to the same object. M. O. Struve examines the effect of supposing a small constant error to exist in all the decli-

nations of one of the two catalogues compared; and he finds, that if all Bradley's declinations are diminished a single second, the pole of solar movement will be shifted twenty degrees to the south. I have personally no belief in the freedom of Bradley's declinations from a constant error exceeding a second, even as depending solely on the mean wearing of his quadrant-centre during the time of his observing with it; and I therefore am induced, by M. O. Struve's remarkable conclusion, to look upon all these determinations of the pole of solar movement with doubt, at least as regards the declination of the assigned point.

I have entered into unusual details, Gentlemen, upon this paper, because I felt that without them I could scarcely explain to you its peculiar merits. The problem of the determination of precession, roughly considered, is extremely simple; but, considered with reference to these minute circumstances which are exhibited only in large masses of observation of the most delicate kind, it is extremely complicated. I have no hesitation in expressing my own opinion that M. Otto Struve has grappled with the various difficulties that present themselves, metaphysical and mathematical, better than any other astronomer whose work on the same subjects I have examined. The two investigations which relate to the determination of the direction and magnitude of the solar movement are, in my opinion, very admirable; but the third, which exhibits the amount of uncertainty in the result depending on venial or probable errors of observation, is, in my judgment, even more valuable. I esteem a rational doubter in science as I esteem a Niebuhr in history—as the only person who is likely to supply at last a firm foundation upon which a solid superstructure may be built.

From what I have already said, you will have gathered my opinion that the subject is not yet entirely exhausted. In the first place, I observe, that the remarks upon the effect of a constant error affecting the declinations of all the stars in the same way suggest the propriety of investigating the effect of an error which affects half the stars in one way and half in another; for such an error does actually exist in the reductions of the stars with an erroneous nutation. In the second place, I trust that no great number of years will elapse before it will be practicable to compare the results of observations made at both epochs with circular instruments; for I have little belief that the results of observations with the quadrant can be free from constant error, of magnitude sufficient seriously to vitiate the final inference. In the third place, I should be glad to see the results of comparisons of the observations of stars which are not ostensibly confined to one class, as that of double stars. And since the date of the investigations of M. Otto Struve, more ample means of an unobjectionable character have been collected. For I must remark that a rather unusual delay has occurred in our notice of this paper. This has arisen partly from the delay which usually occurs in the printing and distribution of foreign memoirs; partly from the time which is necessary for thoroughly reading a paper of

such length; but principally from the occupation of the minds of astronomers, as well within as without the Society, by the remarkable planetary discoveries made in several years past.

But these remarks are entirely prospective, and have nothing to do with our opinion on the merits of the paper before us, or on its claims to the warmest expression of the high estimation of this Society. I am sure, Gentlemen, that those who have been able to follow the account which I have endeavoured to give of the state of our knowledge of the subjects to which it refers, of the skill and caution with which these subjects are here treated, and of the peculiarly valuable character of the results obtained, negative as well as positive, will agree with me, that on two of the most interesting subjects in astronomy (the precession of the equinoxes and the solar movement) M. O. Struve has given to the world a paper of the most important character, worthy of himself and worthy of the name which he bears. On the award of the Council, and I am sure with your full approbation, in the name of the Society I deliver to our Foreign Secretary, to be transmitted to M. Otto von Struve, the Medal of the Society.

The President then, delivering the Medal to Mr. Hind, Foreign Secretary, addressed him in the following terms:—

In transmitting this medal to M. Otto von Struve, convey to him our assurance that this Society, in common with all the astronomers of the civilised world, regard with the utmost interest the investigations conducted by his father, by himself, and by his colleagues, in regard to those points of astronomy which have now for some years been the distinctive objects of pursuit at the Observatories of Dorpat and Pulkowa. And express to him our confidence, that both in his connexion with the astronomical observations of Pulkowa and in his superintendence of the astronomical operations of the Russian Survey, his life will be distinguished by a series of investigations equally interesting and equally successful with that which forms the subject of the present Medal.

The Meeting then proceeded to the election of the Officers and Council for the ensuing year, when the following Fellows were elected:—

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G. B. Airy, Esq. M.A. F.R.S. Astronomer Royal.

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